2. RESULTS - PRESENTATION OF THE BOTANICAL DATA

2.1 The SSSI 'Control' Field

2.1.1 *Frequency of species within the RM-Q dataset*

Random mini-quadrat (RM-Q) data for the SSSI 'control' field are summarised in Table 1.

2.1.1.1 Since 1994 species-richness (mean number of vascular plant species per RM-Q), given at the bottom of Table 1, appears to have stabilised, the index for 1996 being only very slightly lower than that recorded in 1995. The considerable overall increase in species-richness since the late 1980s is likely to have been a consequence of the reinstatement of cutting-and-grazing management following several years of neglect (Annex 1).

2.1.1.2 Many species were found in 1996 at their highest (or equal-highest) frequencies on record, including *Dactylis glomerata* (Cock's-foot)[1], *Danthonia decumbens* (Heath-grass) (= *Sieglingia decumbens*), *Holcus lanatus* (Yorkshire Fog), *Carex caryophyllea* (Spring Sedge), *C.flacca* (Glaucous Sedge), *Juncus acutiflorus* (Sharp-flowered Rush), *Hypochaeris radicata* (Cat's-ear), *Leucanthemum vulgare* (Oxeye Daisy) (= *Chrysanthemum leucanthemum*), *Orchis morio* (Green-winged Orchid), *Ranunculus acris* (Meadow Buttercup), *Trifolium pratense* (Red Clover) and *T.repens* (White Clover). RM-Q data suggest that, in line with the overall increase in species-richness, most species now occur at considerably higher frequencies than they did during the early years of the study period (1988-91).

2.1.1.3 *Orchis morio* had another excellent year in 1996, the count of 8,160 flowering spikes being the highest on record (Table 2). As noted in 1995, its distribution in the SSSI continues to be very patchy, with largest concentrations in the northern quarter of the field. In some areas in 1996 flowering spikes (including large numbers in bud) were so densely packed that they were impossible to count accurately, and we suspect that our total count underestimated the actual total, with many plants 'in bud' likely to have been overlooked. As in 1995, our impression was that *Dactylorhiza praetermissa* (Southern Marsh-orchid) (= *D.majalis* ssp *praetermissa*) and *D.fuchsii* (Common Spotted-orchid) were also doing well, though

[1] Nomenclature follows Stace (1991) and Kent (1992), though on first mention of a species in the text synonyms are also given if these are still widely used; English names follow Stace (1991), and are given within brackets following first mention of the species.

D.praetermissa occurred at much lower frequency in the RM-Qs than in 1994 or 1995. It is possible that its frequency in earlier years had been overestimated due to confusion with non-flowering *O.morio*.

2.1.1.4 A few species did poorly in 1996: *Poa pratensis/humilis* (Smooth Meadow-grass/Spreading Meadow-grass) (*P.humilis* = *P.subcaerulea*)[1], *Potentilla reptans* (Creeping Cinquefoil) and *Taraxacum* sp. (Dandelion) were recorded at their lowest frequencies on record, while *Cerastium fontanum* (Common Mouse-ear) and *Luzula campestris* (Field Wood-rush)[2] were at their lowest frequencies since 1991. Both these latter species typically prefer moist conditions (Grime *et al.*, 1988); at Brocks Farm they appear to increase following wet years, and their marked decline since 1994 is probably related to recent spring-summer droughts. This may also account for the changing fortunes of *Taraxacum* sp., with low frequencies following 'dry' years and high frequencies following 'wet' years (though the pattern of fluctuating frequencies was different in the SSSI from in the transplanted grasslands). On the other hand, the decline of *P.pratensis/humilis* may be a management effect, with grazing early in the year possibly coinciding with its main period of vegetative growth in spring (Grime *et al.*, 1988).

2.1.2 *FIBS analysis of changes, 1988-1996*

Once again, in 1996 there was very little change in the FIBS 'profile' for the SSSI grassland (Table 3). The conclusions drawn from the analysis are much the same as those given in previous 'update' reports, and are as follows:-

2.1.2.1 **Strategy**[g]. Throughout the study period there has been very little change in the balance of strategies, the 1996 'profile' being identical to that recorded in 1995. For the third year running stress-tolerant ruderals (SR-strategists) did particularly well; we suspect that hay-cutting in summer and occasional grazing between autumn and early spring is important here, producing an open-textured or 'gappy' turf. Moles, too, are having an increasing and possibly significant impact. This would also help to explain the recent increase of

[1] There was much confusion between *P.pratensis* and *P.humilis*; initially, all *Poa* plants (unless *P.trivialis*) were recorded as *P.pratensis*, but close examination of '*P.pratensis*' in 1991 revealed both taxa were present. Thereafter we decided to treat the taxa as a species-pair.

[2] In earlier progress reports we listed only the species-pair *Luzula campestris/multiflora*, to allow for the possibility that both *L.campestris* and *L.multiflora* were present; however, recent critical examination of *Luzula* at Brocks Farm has revealed only *L.campestris*.

Ranunculus bulbosus (Bulbous Buttercup), which is known to need gaps in the sward in autumn for seed germination and successful seedling establishment (Harper, 1957; Grime *et al.*, 1988). Representation of stress-tolerators (S-strategists) has been sustained throughout the study period, averaging 14% in 1988/89/90, 15% in 1991/92/93, and 16% in 1994/95/96.

2.1.2.2 **Habitat** [g]. Representation of 'pasture' species continues to be at a higher level than in the late 1980s; again, this indicates continuation of favourable cutting-and-grazing management. As if to underline this fact, 'wasteland' species (often indicative of *under*-management) have continued to decline, in 1996 being at their lowest level on record.

2.1.2.3 **Species richness** [g] . Representation of species typically associated with species-rich vegetation remains at a relatively high level; this indicates that many 'desirable' species in conservation terms (those tending to be associated with species-rich communities) are continuing to thrive.

2.1.2.4 **Canopy height** [g] **and canopy structure** [g]. The previously noted increase in representation of species having a 'basal' (rosette) canopy structure and low canopy height (ie species that one would expect to be favoured by grazing (Hodgson *et al.*, 1995)) is still readily apparent, and is mirrored by a declining representation of 'leafy' species. 'Leafy' species are those without a basal rosette, with aerial leaves only, and include many taller-growing plants likely to be susceptible to grazing or cutting. These observations are in line with known changes in management regime.

2.1.2.5 **Vegetative spread** [g]. Species capable of extensive lateral vegetative spread (>250mm) have declined, while those forming small (<250mm) patches have increased. This is also in line with known management changes, our observations elsewhere suggesting that small patch-formers tend to do relatively poorly in under-managed/derelict situations, but benefit from cutting-and-grazing which produces a more finely-textured sward.

2.2 The Turf Transplant

2.2.1 *Frequency of species within the RM-Q dataset*

Random mini-quadrat (RM-Q) data for the turf transplant are summarised in Table 4.

2.2.1.1 There was a further increase in mean number of vascular plant species per RM-Q (given at the bottom of Table 4), the 1996 index of 9.7 being the highest on record. As in previous years, this was slightly (8.4%) down on the index for the SSSI.

2.2.1.2 Several species occurred in 1996 at their highest (or equal-highest) frequencies since the start of the monitoring programme, including *Poa pratensis/humilis, Juncus acutiflorus, Luzula campestris, Hypochaeris radicata, Oenanthe pimpinelloides* (Corky-fruited Water-dropwort), *Ranunculus bulbosus, Rhinanthus minor* (Yellow-rattle), *Trifolium pratense* and *T.repens*. In 1996 two species appeared in the RM-Q dataset for the first time, *Leontodon saxatilis* (Lesser Hawkbit) (= *L.tar-axacoides*) and *Trifolium dubium* (Lesser Trefoil), both occurring in 10% of the quadrats. Observations at other sites indicate that both these species do well in drought-prone grasslands, and can increase markedly following dry years. Their sudden upsurge in 1996 in the turf transplant (in contrast to the SSSI, where they do occur but at much lower frequencies) suggests that parts of the turf transplant (chiefly along the central 'ridge') may be particularly susceptible to drought.

2.2.1.3 In previous reports we noted the spread of two post-transplant colonists, *Carex hirta* (Hairy Sedge) and *Equisetum arvense* (Field Horsetail). *C.hirta* was recorded in 1996 in 11% of RM-Qs, its equal-highest frequency on record. It showed little sign of further expansion in 1996, although our field observations suggested that within the areas in which it occurs there had been a considerable increase in the density of shoots. In 1996 *Equisetum arvense* was largely confined to grassland alongside the perimeter ditch. Both species are likely to do well during a run of wet seasons (not the case in 1996), with their distributions centred on parts of the site particularly prone to waterlogging following heavy rain. This is also true of *Ranunculus repens* (Creeping Buttercup), which in 1996 declined sharply (down from 29% in 1995 to 12% in 1996), possibly due to the 1995-96 drought.

2.2.1.4 There has been a marked increase in recent years of *Oenanthe pimpinelloides*, which in 1996 continued to occur at higher frequency in the turf transplant than in the SSSI (see Tables 1 and 4). As noted in previous 'update' reports, the turf transplant receptor site is clearly proving well-suited to this species, and we suspect from observation that an altered hydrological regime may be partly responsible.

2.2.1.5 In 1996 several species continued to do poorly in the turf transplant, in comparison with their performance in the SSSI and/or the littered plot. *Danthonia decumbens, Leucanthemum vulgare* and *Prunella vulgaris* (Self-heal) all remained at low frequencies, in contrast to their marked increase in recent years in the SSSI and littered plot. In comparison with the SSSI, *Carex caryophyllea*, *C.flacca* and *Dactylorhiza praetermissa* are also clearly failing to thrive in the turf transplant. The 1996 spike count of *Orchis morio* produced a much higher total than in previous years, but the overall increase in number of flowering spikes has been far less than in the SSSI (Table 2).

2.2.1.6 As noted in the 1994 and 1995 'update' reports, it is surprising that *Plantago lanceolata* (Ribwort Plantain) has behaved so differently in the SSSI and turf transplant (in the SSSI having gone up from 44% in 1988 to 80+% during 1992/3/4/5/6; while in the turf transplant remaining more or less stable - 50% in 1988 and 44-50% during 1992/3/4/5/6). It is unclear why this species has failed to increase in the turf transplant, given that management of the two areas have been similar throughout the study period. However, *P.lanceolata* has a deep rooting system (Sagar & Harper, 1964), so it is possible that seedling recruitment in the turf transplant could have been offset by the death of adult plants 'root-pruned' during transplantation. Alternatively, changes to the soil mycoflora could have had an impact on *P.lanceolata* abundance, since mycorrhizal infection is known to cause significant increases in seedling yield (Grime *et al.*, 1988).

2.2.2 *FIBS analysis of changes, 1988-1996*

In 1996 there was very little change in the FIBS 'profile' for the turf transplant grassland (Table 5), and the conclusions drawn from the analysis are much the same as those given in previous 'update' reports. The following points are worth reiterating:-

2.2.2.1 **Strategy**. During the study period there has been a marked shift in the balance of strategies; of particular note has been the decline in representation of stress-tolerators (S-strategists) - 13% pre-transplant, and averaging 10% in 1988/89/90, 8% in 1991/92/93 and 7% in 1994/95/96.

2.2.2.2 **Habitat.** Representation of 'pasture' species declined in 1996, while there was a very slight increase of 'wasteland' species. However, both attributes appear to be fairly stable overall, apart from a sharp decrease in representation of 'wasteland' species from 1989 onwards (probably in response to reinstatement of hay-meadow management). There appears to have been a marked increase in representation of 'arable' species (ie species usually indicative of high fertility and moderate levels of disturbance).

2.2.2.3 **Canopy height and canopy structure.** In 1996, representation of low-growing (<100mm) and 'basal' (rosette) species was the highest on record. Species having these attributes would be expected to do well under grazing treatments (Hodgson *et al.*, 1995), so observed changes are in line with known changes in management regime.

2.2.2.4 **Vegetative spread.** As noted in previous 'update' reports, there has been an overall increase in 'small' patch-formers and a decline in representation of 'large' patch-formers. Again, this is consistent with the increased intensity of management in recent years. In the 1995 'update' we noted that, paradoxically, representation of species capable of spread >1000mm had increased sharply - these include *Carex hirta, Juncus acutiflorus* and *Ranunculus repens*, which all did well in 1995 - but representation of large patch-formers dropped again in 1996, due largely to the 'crash' of *R.repens*. (But note that *J.acutiflorus*, which increased in 1996 for the third year running, was at its highest frequency since the start of the monitoring programme.)

2.2.2.5 **Flowering time.** There has been a substantial increase in representation of species which typically flower in May, and a corresponding decline in representation of species flowering in April and June. Reasons for this shift are unclear, but it is in marked contrast to the SSSI and littered plot.

2.2.2.6 **Present status (GB)** [g]. Following transplantation there was a decline in representation of species considered within the FIBS database to be *declining nationally* and, conversely, an increased representation of species thought to be *increasing nationally*. This is one indication of a lowering of interest in nature conservation terms, given that greater value is generally placed on species which are in decline nationally. In 1996 this post-transplant change was still apparent.

2.3 The Littered Plot

2.3.1 *Frequency of species within the RM-Q dataset*

Random mini-quadrat (RM-Q) data for the littered plot grassland are summarised in Table 6.

2.3.1.1 In 1996 there was a marked decrease in species-richness (mean number of vascular plant species per RM-Q), given at the bottom of Table 6, the index of 9.7 being 18% down on that recorded in 1995. We suspect this was due to drought-stress, poor seed germination and/or survival of seedlings (and possibly mortality of 'adult' plants) between summer 1995 and spring 1996 resulting in reduced frequencies of some species. In the littered plot in 1996 the sward was still very open, and we have noted that high species-richness in previous years has often depended partly on the presence of large numbers of seedlings of various species attempting to colonise the gaps. Clearly many seedlings fail to survive through to 'adulthood', meaning that poor germination or heavy seedling mortality in one year can produce an immediate and discernible drop in species-richness.

2.3.1.2 Of the species undergoing an apparent post-transplant 'crash', *Luzula campestris* maintained the (very modest) 'partial recovery' noted in earlier 'update' reports, while *Rumex acetosa* (Sorrel) declined once again. *Ranunculus acris* increased for the fourth year running, recovering in 1996 to its pre-transplant level (though still considerably lower than the 1996 value for the SSSI). *Ranunculus repens* and *R.bulbosus*, on the other hand, continued to be present at very low frequencies in comparison with pre-transplant levels. Several other species showing modest signs of recovery in 1995 declined again in 1996, including *Ajuga reptans* (Bugle), *Potentilla erecta* (Tormentil) and *Succisa pratensis* (Devil's-bit Scabious).

2.3.1.3 Several species were found in 1996 at their highest frequencies on record, including *Cynosurus cristatus* (Crested Dog's-tail), *Festuca rubra* (Red Fescue), *Carex flacca, Juncus acutiflorus* and *Hypochaeris radicata*. In general, these species have shown comparable increases in the SSSI and/or turf transplant. However, there are several other species - including *Holcus mollis* (Creeping Soft-grass), *Leontodon saxatilis* and *Ulex europaeus* (Gorse) - which clearly benefitted from the disturbance of transplantation and subsequent open, highly 'stressed' conditions, and which continue to occur at much higher frequencies in the littered plot than in either the SSSI or turf transplant.

2.3.1.4 *Orchis morio*, too, continued to do well (Table 2), the spike count in 1996 being 93% up on the 1995 total. In the 1995 'update' report we suggested that the combination of post-transplant bare ground and switch from 'drought' to 'deluge' in 1991-92 had produced ideal conditions for seed germination of *O.morio* in 1991-93, and this could account for the recent upsurge in the number of flowering spikes. As already noted in 2.3.1.1, however, drought-stress appears to be particularly severe in the littered plot (see also 4.3.2.2), possibly leaving *O.morio* more vulnerable there than in the SSSI or turf transplant.

2.3.1.5 There are several 'pre-transplant' species which, in recent years, have occurred in the littered plot at higher frequencies than in the turf transplant, including some which prior to transplantation were more prominent in the grassland subsequently moved as turves. This indicates that, at least for these species, the environmental context of the littered plot is currently proving more 'congenial' than that of the turf transplant. Species in this category include *Anthoxanthum odoratum* (Sweet Vernal-grass), *Danthonia decumbens*, *Carex caryophyllea*, *C.flacca*, *Centaurea nigra* (Common Knapweed) and *Lotus corniculatus* (Common Bird's-foot-trefoil). Other species clearly doing better in the littered plot than in the turf transplant include *Prunella vulgaris*, *Leucanthemum vulgare*, *Hypochaeris radicata* and *Potentilla reptans*.

2.3.2 *FIBS analysis of changes, 1988-1996*

In 1996 there was very little change in the FIBS 'profile' for the littered plot grassland (Table 7), and the conclusions drawn from the figures are much the same as those given in previous 'update' reports. The following points are worth reiterating:-

2.3.2.1 **Strategy.** In recent years there has been very little change in the strategy 'profile'. The post-transplant upsurge of ruderals (R-strategists), stress-tolerant ruderals (SR-strategists) and competitive ruderals (CR-strategists) was not maintained beyond 1989, though several species involved in this upsurge have persisted in the sward (eg *Juncus bufonius* (Toad Rush) and *Isolepis setacea* (Bristle Club-rush), still present in 1996 although not recorded in the RM-Qs).

2.3.2.2 **Habitat.** 'Wetland' species continue to be more prominent here than in either of the other plots, perhaps reflecting a tendency for parts of the littered plot to collect surface water after heavy rain (see also 4.3.2.2). However, it should be noted that prior to transplantation 'wetland' species were already more frequent in the vegetation to be transplanted by littering than in other areas.

2.3.2.3 **Nuclear DNA and flowering time**. Following transplantation there was a substantial decline in representation of species having estimated nuclear DNA >10pg. In general, species having large amounts of nuclear DNA grow mainly in the cooler seasons of the year, whereas those with small DNA amounts have growth mainly restricted to summer (Grime & Mowforth , 1982; Grime *et al.*, 1988; Hodgson *et al.*, 1995). The decline of species having high DNA amounts could be linked to the decline of May-flowering species and an increase of species typically flowering in June and July. Reasons for this shift are unclear, but it is in marked contrast to the SSSI and turf transplant.

2.3.2.4 **Vegetative spread.** In 1996, species capable of extensive lateral spread continued to be relatively well represented in the littered plot (eg *Juncus acutiflorus* and *Pulicaria dysenterica* (Fleabane) - both of which are stress-tolerant competitors (SC-strategists)). The post-transplant upsurge of monocarpic species, however, was short-lived, such species consistently occurring at very low frequencies since 1990.

3. A COMPARISON OF FLORISTIC CHANGES IN THE THREE MONITORING AREAS

3.1 Importance of the SSSI grassland as a 'control'

3.1.1 Many changes have taken place in the SSSI grassland since we began our work there in 1988, and these emphasise that - without being transplanted - grasslands of this sort are dynamic and responsive to external factors. Clearly, even had they remained *in situ* the transplanted grasslands would still have changed. The question is not "have the transplanted grasslands changed?", but rather "have they changed *differently* from what one would have expected had they not been transplanted?"

3.1.2 Fortunately, all three monitoring areas have been subject to similar management regimes (Annex 1) - the only exception being that the littered area was left unmanaged in 1989-90 while the sward was re-establishing[1]. This means that the SSSI grassland can be used as a 'control' for comparison with the transplanted swards, allowing the effects of transplantation to be separated out from management- or climate-related effects common to all three monitoring areas.

3.2 Changes in the turf transplant in comparison with changes in the SSSI 'control' grassland

3.2.1 *Species-richness*

3.2.1.1 At the outset, it is important to stress that one should not lay too much weight on species-richness *per se*, since it takes no account of the 'desirability' of the species present. Increased species-richness is not always a 'good thing' (for example, the extra species may be opportunist 'weeds'), while important floristic differences may lie concealed behind identical indices of species-richness.

3.2.1.2 Nevertheless, it is worth noting that, prior to transplantation, the turf transplant donor area and adjoining SSSI had almost exactly the same mean number of vascular plant species per RM-Q, and that, since 1988, there has been a clear trend in both areas towards increasing species-richness: up by 33% since 1988 on the turf transplant, compared with 41% on the SSSI over the same time period.

3.2.1.3 While the pattern of change in species-richness has been similar in the two areas, the turf transplant has generally lagged behind somewhat (Figure 1); and the pronounced decline in

[1] Note, however, that according to ECCI management records (Annex 1) the littered area was cut in 1989 and 1990, but that cuttings were left on the ground as there were not enough to bale up for hay. This was also apparently the case in 1991.

species-richness in the turf transplant following transplantation suggests that much of this 'lagging behind' has been a medium- to long-term consequence of transplantation. Our impression in 1996 (as in earlier years) was that, while large parts of the turf transplant were as species-rich as the SSSI, there were nevertheless still some patches of extremely species-poor vegetation where transplanted turves had failed to establish. This impression is supported by data presented in Figure 2, which suggests that the turf transplant's lower overall species-richness is in part due to a small contingent of RM-Qs falling within these species-poor patches.

3.2.2 *Frequency of individual species*

3.2.2.1 An examination of the frequency data in Table 1 (SSSI) and Table 4 (turf transplant) indicates that many species appear to performing rather differently in the SSSI and turf transplant. Species can be grouped according to their relative performance in the two areas. These groupings are summarised in 3.2.2.3 - 3.2.2.8 below.

3.2.2.2 It should be noted that in drawing up these species-groups we have omitted species which are poorly represented within the RM-Q dataset, as well as those which, prior to transplantation, had markedly differing frequencies in the SSSI and turf transplant donor area. This means that, as far as possible, we are comparing the performance of species which at the start of the monitoring programme occurred at similar frequencies in the two areas.

3.2.2.3 **Species doing equally well or badly in both SSSI and turf transplant**. Species *either* having similar frequency and pattern of fluctuations in frequency from year to year in both areas, *or* having somewhat dissimilar fluctuations but not performing consistently better in either SSSI or turf transplant (Figure 3): seven species - *Achillea millefolium* (Yarrow), *Cerastium fontanum, Lotus pedunculatus* (Greater Bird's-foot-trefoil) (= *L.uliginosus*), *Pulicaria dysenterica, Rumex acetosa, Taraxacum* sp., *Trifolium repens.*

3.2.2.4 **Species doing better in SSSI than in turf transplant (1).** Species having similar pattern of fluctuations in frequency from year to year in both SSSI and turf transplant but which, following transplantation, have performed better in the SSSI in most or all years (Figure 4): nine species - *Anthoxanthum odoratum, Carex caryophyllea, Centaurea nigra, Festuca rubra, Lotus corniculatus, Luzula campestris, Ranunculus acris.* Also *Carex flacca* which, while the pattern of fluctuation on the two areas has been quite different, has nevertheless consistently done better on the SSSI; and *Orchis morio* which, while increasing in the turf transplant (as revealed by spike counts), is doing consistently less well there than in the SSSI (Table 2).

3.2.2.5 **Species doing better in SSSI than in turf transplant (2).** Species increasing markedly in the SSSI, but with little or no sign of a comparable increase in the turf transplant (Figure 5): five species - *Dactylis glomerata, Danthonia decumbens, Leucanthemum vulgare, Plantago lanceolata, Prunella vulgaris.*

3.2.2.6 **Species which until recently have done better in SSSI than in turf transplant.** Species increasing markedly in the SSSI and initially showing little sign of increasing in the turf transplant, but which in recent years have become as frequent there as in the SSSI (Figure 6): two species - *Hypochaeris radicata, Trifolium pratense.*

3.2.2.7 **Species doing better in turf transplant than in SSSI (1).** Species having similar pattern of fluctuations in frequency from year to year in both SSSI and turf transplant but which, following transplantation, have done better in the turf transplant than in the SSSI in most or all years (Figure 7): three species - *Agrostis capillaris* (Common Bent), *Holcus lanatus, Stellaria graminea* (Lesser Stitchwort).

3.2.2.8 **Species doing better in turf transplant than in SSSI (2).** Species *either* increasing markedly in the turf transplant, but showing little sign of a comparable increase in the SSSI, *or* post-transplant colonists which have persisted in the turf transplant, and which are apparently absent from the SSSI (Figure 8): five species - *Carex hirta, Equisetum arvense, Ranunculus repens, Rhinanthus minor.* Also *Oenanthe pimpinelloides* which, while increasing in the SSSI, is doing less well there than in the turf transplant.

[*Lathyrus pratensis* (Meadow Vetchling) has also done consistently better in the turf transplant, though was more abundant there than in the SSSI even *before* transplantation.]

3.2.2.9 In summary, it appears that, of the 31 species for which reliable comparisons can been made, seven have done equally well (or badly) in both SSSI and turf transplant, eight (including three 'persisting' post-transplant colonists) have done consistently better in the turf transplant, and 16 have done better in the SSSI in most or all years. Of these 16 species, only two now show signs of having attained similar levels of frequency in the turf transplant as in the SSSI, leaving

14 species which continue to thrive less well in the turf transplant than in the SSSI. Thus, the frequency data point to a relatively large number of species that in the turf transplant are performing poorly in comparison to the SSSI. Further consideration of these differences in terms of their impact on the conservation importance of the grassland *community* is given in 3.2.4, and in Gibson (1997).

3.2.3 *FIBS analyses*

3.2.3.1 In 2.1.2 and 2.2.2 (Table 3 (SSSI) and Table 5 (turf transplant)) we highlighted a number of changes in the frequency of occurrence of certain species' *attributes* (eg canopy structure, habitat preference, flowering time) within the RM-Q datasets. Species sharing a particular attribute form what may be termed a *functional* grouping of species, with changes in their frequencies of occurrence causing the frequency of that *attribute* to change. Obviously, attributes are interlinked (for example, many 'stress-tolerators' are also 'decreasing nationally' and are typically associated with vegetation having 'high species richness'); taken together, however, they allow us to build up a picture of which kinds of species are decreasing and increasing in the two monitoring areas. In this way, we can examine the floristic changes in terms of their *functional* significance.

3.2.3.2 **Strategy.** Within the strategy 'profiles' there is a marked contrast in representation of stress-tolerators (S-strategists), in the SSSI having remained more or less stable, while in the turf transplant having declined sharply in 1990, and six years later still showing no sign of recovery (Figure 9). S-strategists include such species as *Carex caryophyllea, C.flacca* and *Danthonia decumbens*, all of which are doing much better in the SSSI than in the turf transplant (see 3.2.2.4-3.2.2.5). In mesotrophic grasslands S-strategists contribute greatly to the 'special interest' of the sward, so their declining representation in the turf transplant indicates a decline in the overall value of this grassland in comparison with the SSSI.

3.2.3.3 **Habitat.** There is little difference between the SSSI and turf transplant in terms of representation of FIBS habitat groupings; in both areas the sward is comprised principally of 'pasture' and 'wasteland' species, with an overall increase of the former and decrease of the latter in both areas probably being a consequence of the reinstatement of hay-meadow management in the late 1980s.

3.2.3.4 **Species richness.** In the SSSI, species typically associated with more species-rich vegetation (>18 species/m^2) have tended to increase, while those usually associated with less species-rich and species-poor vegetation ($\leq$18 species/m^2) have decreased. In the turf transplant representation of species associated with species-rich vegetation has failed to increase (Figure 10).

3.2.3.5 **Canopy height, canopy structure and vegetative spread.** In both areas there has been an increase in species having low canopy height (<100mm) and/or a 'basal' (rosette) canopy structure, and a decline in species capable of forming large (>250mm) patches by lateral vegetative spread. In both areas there has also been a marked increase since 1992 in the representation of small (<100mm) patch-formers, although the overall increase between 1988 and 1996 has been more pronounced in the SSSI. As already noted, these changes are likely to have been due to the reinstatement of cutting-and-grazing management in the late 1980s, and they suggest that the functional consequences of management in the two areas have been similar.

However, against these trends, in the turf transplant there has been a slight overall (1988-96) increase in representation of the *largest* patch-formers, those capable of lateral spread >1000mm. As noted in 2.2.2.5, this has been largely due to recent increases of *Carex hirta, Juncus acutiflorus* and *Ranunculus repens*. Reasons for these increases are unclear, although all are species that would probably have benefitted from several 'wet' years in the early 1990s; the presence of pockets of ill-drained ground might also be working in their favour.

3.2.3.6 **Flowering time**. There has been little change in representation of species having different flowering times in the SSSI, other than a decline of those typically flowering in June. In the turf transplant, however, there has been a striking decline in representation of both June- and April-flowering species and an increase of those typically flowering in May. Reasons for this change in the turf transplant are unclear: it would often be used to infer a temporal shift in management (Hodgson *et al.*, 1995) yet, as far as we are aware, both SSSI and turf transplant have been managed in a similar way throughout the study period (Annex 1). It seems likely, then, that the change was caused in some way by transplantation.

3.2.3.7 **Present status (GB).** In the SSSI there has been little overall change in representation of species thought to be either increasing or decreasing nationally. In contrast, in the turf transplant there was a marked post-transplant *decline* in the representation of species considered to be decreasing nationally, and an *increase* in those species thought to be increasing nationally. As noted in 2.2.2.6, this reflects an overall 'lowering of interest' of the turf transplant, since nationally *declining* species are generally accepted as being more in need of conservation (and, therefore, tend to be valued more highly) than species which are *increasing*.

3.2.4 *An examination of the changes in terms of NVC categorisation and performance of species known to be characteristic of particular NVC (sub-) communities*

3.2.4.1 Prior to transplantation, the vegetation of both SSSI and donor field was considered to be *Cynosurus cristatus-Centaurea nigra* grassland (=*Centaureo-Cynosuretum*), as described in the National Vegetation Classification (NVC) [g] (Rodwell, 1992). This is an important community in conservation terms, having "become increasingly rare as a result of agricultural improvement" (Rodwell, 1992; p61). Its presence at Brocks Farm was a major reason for SSSI notification in 1986.

3.2.4.2 The *Centaureo-Cynosuretum* (code-numbered 'MG5' in the NVC) is divided into three sub-communities: a *Lathyrus pratensis* sub-community (MG5a), the most widespread of the MG5 sub-communities; a *Galium verum* (Lady's Bedstraw) sub-community (MG5b), of "more restricted occurrence, largely over calcareous bedrocks" (Rodwell, 1992; p63); and a *Danthonia decumbens* sub-community (MG5c), perhaps the most restricted of the three, but extending the "range of the community on to the upland margins of the Welsh borderlands and northern England" (Rodwell, 1992; p63).

3.2.4.3 In the 1994 'update' (relevant extracts given in Annex 3) it was concluded that much of the SSSI grassland was best regarded as intermediate between MG5a and MG5c, with some areas of well-characterised MG5c. On the other hand, the turf transplant had relatively poor representation of MG5c preferential species (those species that, within MG5, show strongest 'preference' for MG5c), with vegetation there being closer to MG5a, apart from a few small patches of 'incipient rush-pasture' on ill-draining ground which were possibly related to the *Holcus lanatus-Juncus effusus* (Soft Rush) rush-pasture (MG10) (Rodwell, 1992; pp88-93).

3.2.4.4 The conclusions of the 1994 'update' report are borne out by many of the floristic changes summarised in 3.2.2: of species failing to thrive in the turf transplant, four - *Prunella vulgaris, Luzula campestris, Danthonia decumbens* and *Carex caryophyllea* - are MG5c preferentials, while only one -

Leucanthemum vulgare - is preferential to MG5a. (Two further MG5c preferentials, *Potentilla erecta* and *Succisa pratensis*, are also either absent or rare in the turf transplant.) *P.vulgaris* and *D.decumbens* have both increased markedly in the SSSI, and our impression has been that since the start of the monitoring programme - and the reinstatement of hay-meadow management - the SSSI grassland has shown a pronounced shift towards MG5c in its overall botanical composition. The turf transplant, on the other hand, has shown no such trend: indeed, of the eight species performing better there than in the SSSI, none are MG5c preferentials - half are either MG5 constants[2] or 'associates' holding no particular preference for any sub-community, while the other half are not listed in the NVC floristic table for MG5 (Rodwell, 1992; pp64-65). **This difference between the SSSI and turf transplant is highlighted in Figure 11, which shows that between 1989 and 1994 there was a widening gap between the two areas in terms of summed frequency-of-occurrence values for MG5c preferentials.**

3.2.4.5 A similar picture emerges when the frequency of MG5 constants is examined, **seven of the 11 MG5 constants apparently thriving less well in the turf transplant than in the SSSI.** This is reflected in the summed frequency-of-occurrence values for MG5 constants for the two monitoring areas (Figure 12).

3.2.4.6 MG5 is frequently a precursor of *Lolium perenne* (Perennial Rye-grass)-*Cynosurus cristatus* grassland (MG6), a less species-rich community of lower conservation value "distinguished... by the constancy of *L.perenne* and *C.cristatus* and the absence of the characteristic suite of meadow species that are typical of [MG5]" (Rodwell, 1992; p71). However, the distinction between MG5 and MG6 is frequently a difficult one to make: "... in many cases, the best that can be hoped for is to place a stand at particular points along a line of continuous variation" (Rodwell, 1992; p29). That being so, one would expect an increasingly impoverished MG5 to shift towards MG6 in its overall botanical composition. Summed frequency-of-occurrence values for MG6 constants and MG6b (*Anthoxanthum odoratum* sub-community) preferentials indicate that such species have - apart from the period 1992-94 - occurred at similar frequencies in both monitoring areas

[2] A 'constant' species is one which occurs within >60% of the NVC quadrat sample for a given community or sub-community - in this case MG5.

(Figure 13)[3]. Thus, the SSSI and turf transplant are much the same in terms of the 'strength of presence' of MG6 constants/MG6b preferentials. Nevertheless, given the relatively weaker representation of MG5 constants and MG5c preferentials in the turf transplant, there is a suggestion here that **the turf transplant MG5 is, in comparison with the SSSI, less like MG5 and more like MG6, and that in recent years this difference between the two areas has become more - rather than less - marked.**

3.3 Changes in the littered plot in comparison with changes in the SSSI 'control' grassland

3.3.1 *Species-richness*

3.3.1.1 Once again, it should be stressed that high species-richness is not necessarily 'a good thing'. In the littered plot, as already noted, post-transplant species-richness was affected by (1) the presence of large numbers of seedlings of various species attempting to colonise the bare ground, and (2) an influx of 'weed' species not found in the pre-transplant sward (eg *Anagallis arvensis* (Scarlet Pimpernel), *Isolepis setacea* and *Juncus bufonius*).

3.3.1.2 In terms of their contribution to species-richness, in 1989 the 'weeds' more than made up for the species that 'crashed' as a result of transplantation; even so, in most years species-richness in the littered plot appears to have been very slightly lower than in the SSSI (Figure 14).

3.3.2 *Frequency of individual species*

3.3.2.1 An examination of the frequency data in Table 1 (SSSI) and Table 6 (littered plot) indicates that many species have been performing very differently in the SSSI and littered plot. Species can be grouped according to their relative performance in the two areas. These groupings are summarised in 3.3.2.2 - 3.3.2.5 below.

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[3] There is some overlap between lists of MG5 constants/MG5c preferentials and MG6 constants/MG6b preferentials; six species appear in both lists, namely *Festuca rubra, Cynosurus cristatus, Holcus lanatus, Trifolium repens, Anthoxanthum odoratum* and *Luzula campestris*. MG6b was selected for this analysis since it appeared to be the floristically closest of the MG6 sub-communities to the turf transplant MG5.

3.3.2.2 **Post-transplant colonists ('weeds').** The most obvious difference between the littered plot and the other monitoring areas was the post-transplant influx of opportunist species (mainly ruderals) colonising bare ground, including *Isolepis setacea, Juncus bufonius* and *Anagallis arvensis* (Figure 15), along with less frequent species such as *Montia fontana* (Blinks), *Stachys arvensis* (Field Woundwort) and *Centaurium erythraea* (Common Centaury). Of these, only the first three achieved prominence in 1989, but even in 1996 they were all (apart from *S.arvensis*) still present in the sward in small quantity. Three further species, *Holcus mollis, Leontodon saxatilis* and *Ulex europaeus*, rare or absent in most years in the SSSI and turf transplant, increased rapidly in the littered plot following transplantation, and have since become firmly established as prominent components of the post-transplant grassland (Figure 16). *U.europaeus* has generally been kept in check by the annual hay-cut, except along the fence-line which runs through the middle of the plot; here a narrow strip of vegetation has been left uncut, and the *Ulex* has grown up into sizeable bushes, indicating how the transplanted grassland would probably have become scrub had cutting-and-grazing management not been reinstated.

3.3.2.3 **Species that underwent a post-transplant decline, and have since performed consistently less well in the littered plot than in the SSSI.** Six species appeared to 'crash' following transplantation - *Festuca rubra, Poa pratensis/humilis, Luzula campestris, Ranunculus acris, R.bulbosus* and *Taraxacum* sp. (Figure 17). (But note that *R.bulbosus* 'crashed' in both areas in 1989, but has since recovered only in the SSSI.) *F.rubra* and *R.acris*, both important components of MG5 grassland (Rodwell, 1992), have recovered somewhat in recent years, although their frequencies in 1996 were still well down on that recorded in the SSSI.

3.3.2.4 **Species that have increased in both littered plot and SSSI.** A few species which have increased in the SSSI have also increased in the littered plot, including *Danthonia decumbens, Hypochaeris radicata, Leucanthemum vulgare* and *Prunella vulgaris* (Figure 18). Of these, only *H.radicata* has also increased in the turf transplant (Figure 6). [Conversely, *Trifolium pratense*, which has increased in both SSSI and turf transplant, has failed to increase in the littered plot (Figure 19).]

Spike counts indicate that *Orchis morio* has increased markedly in both littered plot and SSSI (Table 2) although, surprisingly, for the littered plot this increase is not readily apparent from the RM-Q data (Table 6).

3.3.2.5 **Species that occurred at markedly higher frequencies in the pre-transplant sward than in the SSSI and turf transplant donor area.** In 1987 we noted several species, mainly those preferring wetter conditions, that were more frequent in the field to be transplanted than in the SSSI (Leach, 1988). Prior to transplantation there were five species occurring in the top half of the donor field (ie donor for the littered area) at much higher frequencies than in either the turf transplant donor area or SSSI, namely *Juncus acutiflorus, Ajuga reptans, Pulicaria dysenterica, Ranunculus repens* and *Succisa pratensis.* Of these, only *J.acutiflorus* and *P.dysenterica* have persisted as conspicuous elements of the sward (Figure 20); indeed, *J.acutiflorus* has increased markedly, and in 1996 was the *third* most frequent species there (cf *sixteenth* most frequent species in the SSSI).

3.3.3 *FIBS analyses*

3.3.3.1 In 2.1.2 and 2.3.2 (Table 3 (SSSI) and Table 7 (littered plot)) we highlighted a number of changes in the frequency of occurrence of certain *attributes* within the RM-Q datasets. As stated in 3.2.3.1, species sharing a particular attribute form a *functional* grouping of species, with changes in their frequencies causing the frequency of that attribute to change. By examining these changes it is possible to build up a picture of which kinds of species are decreasing and increasing in the two monitoring areas. In this way, we are able to assess the floristic changes in terms of their *functional* significance.

3.3.3.2 **Strategy**. Within the 'strategy' profiles there are some clear differences between the littered plot and SSSI, with a marked increase in representation of stress-tolerators (S-strategists) and post-transplant 'crash' (followed by partial recovery) of CSR-strategists in the littered plot (Figure 21). There was also a temporary post-transplant increase of ruderals (R-strategists) and competitive-ruderals (CR-strategists).

3.3.3.3 **Habitat**. 'Wetland' species have been more strongly represented in the littered plot than in the SSSI throughout the study period, reflecting a difference between the two grasslands that was evident even *before* transplantation. 'Pasture' species, on the other hand, have generally been less well-represented in the post-transplant grassland than in either the pre-transplant grassland or the SSSI. ('Pasture' species have clearly failed to respond to management to the extent that they have in the SSSI.) In the littered plot there was a temporary post-transplant increase of 'arable' species (reflecting a sudden influx of species favouring conditions of high fertility and high disturbance).

3.3.3.4 **Species richness.** In both SSSI and littered plot there has been an increase in representation of species typically associated with more species-rich vegetation (>18 species/m^2), but species associated with species-poor vegetation ($\leq$ 14 species/m^2) have generally been more prominent in the littered plot (Figure 22).

3.3.3.5 **Nuclear DNA and flowering time.** The decline in representation in the littered plot of species having nuclear DNA >10pg (2.3.2.3) is in marked contrast with the SSSI (Figure 23). This may be linked to the decline in the littered plot of species typically flowering in May and an increase in those flowering in June and July. The reasons for this shift are unclear, although the fact that the post-transplant decline has been followed by a partial recovery does suggest that it may have been a medium- to long-term consequence of transplantation.

3.3.3.6 **Canopy structure, canopy height and vegetative spread.** For these attributes the SSSI and littered plot have shown broadly similar trends, with an increased representation of low-growing and/or rosette species and those capable of forming only small (<100mm) patches, in both areas probably being as a result of the introduction of cutting-and-grazing management. In the littered plot there was a temporary post-transplant increase in representation of monocarpic species (most R-strategists are monocarpic). It is also worth noting that, paradoxically, species able to form extensive patches (>1000mm) are doing much better in the littered plot than in the SSSI - these include species such as *Juncus acutiflorus* and *Pulicaria dysenterica* which have consistently occurred at higher frequencies in the littered plot than in either of the other monitoring areas.

3.3.3.7 **Present status (GB).** In the SSSI there has been little change in representation of species thought to be either increasing or decreasing nationally. In contrast, representation of these attributes has changed markedly in the littered plot, with a temporary post-transplant shift in favour of species *increasing* nationally, then subsequently a shift the other way, such that the overall change has been very slightly in favour of species considered within the FIBS database to be *declining* nationally.

3.3.3.8 The FIBS analyses indicate that the littered plot grassland differs from the SSSI in a number of respects. While a few of these differences were already apparent in the pre-transplant sward, transplantation itself appears to have been responsible for many of the functional changes that have occurred. However, some 'desirable' attributes have become well-represented in the littered plot grassland (eg % occurrence of stress-tolerators, species associated with species-rich vegetation, species thought to be declining nationally), reflecting the fact that it does still hold considerable floristic interest, despite it now being less similar than the turf transplant to the SSSI, and despite it having clearly changed from its pre-transplant condition to a greater extent than the turf transplant.

3.3.4 *An examination of the changes in terms of NVC categorisation and performance of species known to be characteristic of particular NVC (sub-) communities*

3.3.4.1 As already noted, prior to transplantation the vegetation of both SSSI and donor field was considered to be *Cynosurus cristatus-Centaurea nigra* grassland (= *Centaureo-Cynosuretum*) (Rodwell, 1992). The subdivision of this community (code-numbered 'MG5' in the NVC) into three sub-communities is summarised in 3.2.3.2.

3.3.4.2 In the 1994 'update' report (relevant extracts are given in Annex 3) we concluded that much of the SSSI grassland was MG5c/MG5a, with some areas of reasonably well-characterised MG5c, and that the turf transplant was MG5a. The littered area, on the other hand, appeared to us to be a quite different community: "... it is not currently possible to categorise it in NVC terms. It has yet to 'settle down', but already is beginning to resemble some kind of mire community; the widespread dominance of *Juncus acutiflorus* suggests the end-community might be closest to *Juncus effusus/J.acutiflorus-Galium palustre* (Common Marsh-bedstraw) rush-pasture [NVC community M23 (Rodwell, 1991)]. The early upsurge of *Ulex europaeus*, on the other hand, indicates that in the absence of management the end-community would probably be... *Ulex* scrub".

3.3.4.3 In our opinion it is still not possible to categorise much of the vegetation in the littered area (of which the littered *plot* is a part). While many elements of MG5/MG5c have persisted (indeed some have increased), these occur intermixed with other elements not normally associated with MG5, meaning that the community *as a whole* looks much less like MG5 than does the SSSI and turf transplant.

3.3.4.4 Summed frequency-of-occurrence values (Figure 24) confirm that in the littered plot representation of MG5 constants has been lower than in the SSSI throughout the study period, though the difference in 1988 (pre-transplant) was less than in any year since. MG5c preferentials, on the other hand, have generally done well, showing a similar level of overall increase to that occurring in the SSSI (Figure 25). In the littered plot two MG5c preferentials - *Danthonia decumbens* and *Prunella vulgaris* - were amongst the species increasing most rapidly during 1991-1993, and this shows up as a 'hump' in Figure 25; both species have since declined somewhat (though in 1996 they still occurred at higher frequencies than in the SSSI).

3.3.4.5 In the littered plot there is a strong contingent of 'non-MG5' species (ie species not listed in the NVC floristic table for MG5 in Rodwell (1992; pp64-65), and several of these are present at relatively high frequencies. They include *Juncus acutiflorus* (in 69% of RM-Qs in 1996), *Leontodon saxatilis* (44%), *Pulicaria dysenterica* (19%), *Ulex europaeus* (12%), *Holcus mollis* (9%), *Lotus pedunculatus* (3%), *Carex hirta* (1%), and *Juncus conglomeratus* (1%). Of course, their absence from the floristic table in Rodwell (1992) does not mean that such species should *never* be found in MG5 - the NVC table, in any case, omits species occurring in <5% of the quadrat sample - but nevertheless one would normally expect them, if present, to make only a minor contribution to the sward[4]. It should be noted that the above list includes three post-transplant colonists (*L.saxatilis, U.europaeus* and *H.mollis*), which together contribute much to the littered area's 'non-MG5' character. Also included is *J.acutiflorus* which, as already noted (3.3.2.5), is becoming increasingly dominant over large sections of the littered area, in contrast to its performance in the SSSI and, to a lesser extent, the turf transplant.

[4] From observations elsewhere, we suspect that *Juncus acutiflorus* can be frequent - though rarely abundant - in MG5 grasslands in south-western England; making its presence at Brocks Farm less 'anomalous' than its omission from the NVC table in Rodwell (1992) would suggest.